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**KING COUNTY CONVEYANCE SYSTEM  
IMPROVEMENT PROJECT**

**TASK 240**

**HIDDEN LAKE SERVICE AREA  
WASTEWATER SERVICE ALTERNATIVE  
DEVELOPMENT**

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**HIDDEN LAKE SERVICE AREA**  
**TASK 240: WASTEWATER SERVICE ALTERNATIVE DEVELOPMENT**

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# INTRODUCTION

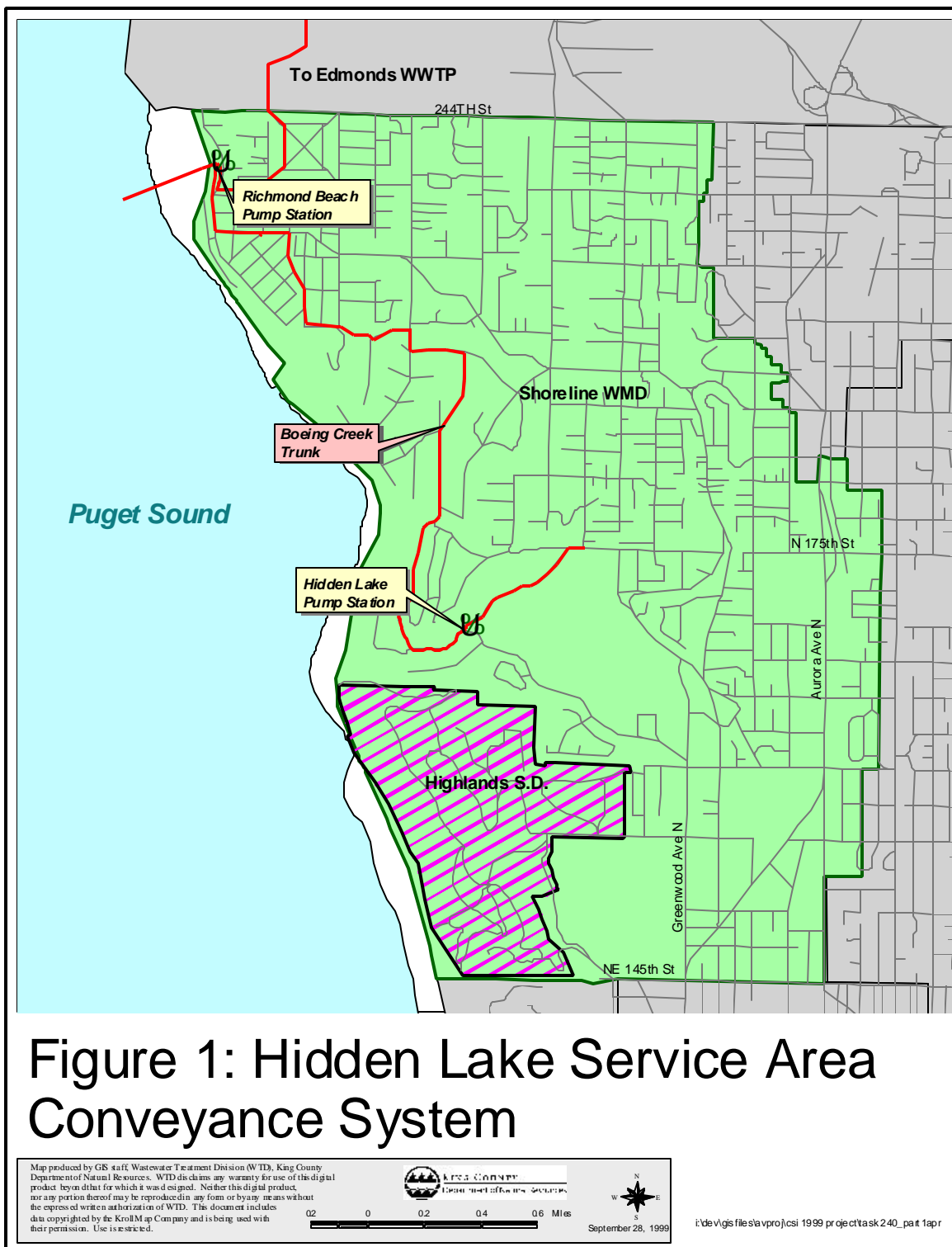
This memorandum addresses the current conveyance system limitations in the Hidden Lake Service Area (Service Area) and describes three alternatives for conveyance system improvement. The development of these alternatives incorporates projected changes in demand based on population forecasts, infiltration and inflow estimates provided by the King County Wastewater Treatment Division (KC WTD), and information provided in the Hidden Lake Task 210, Task 220 and Task 230 reports.

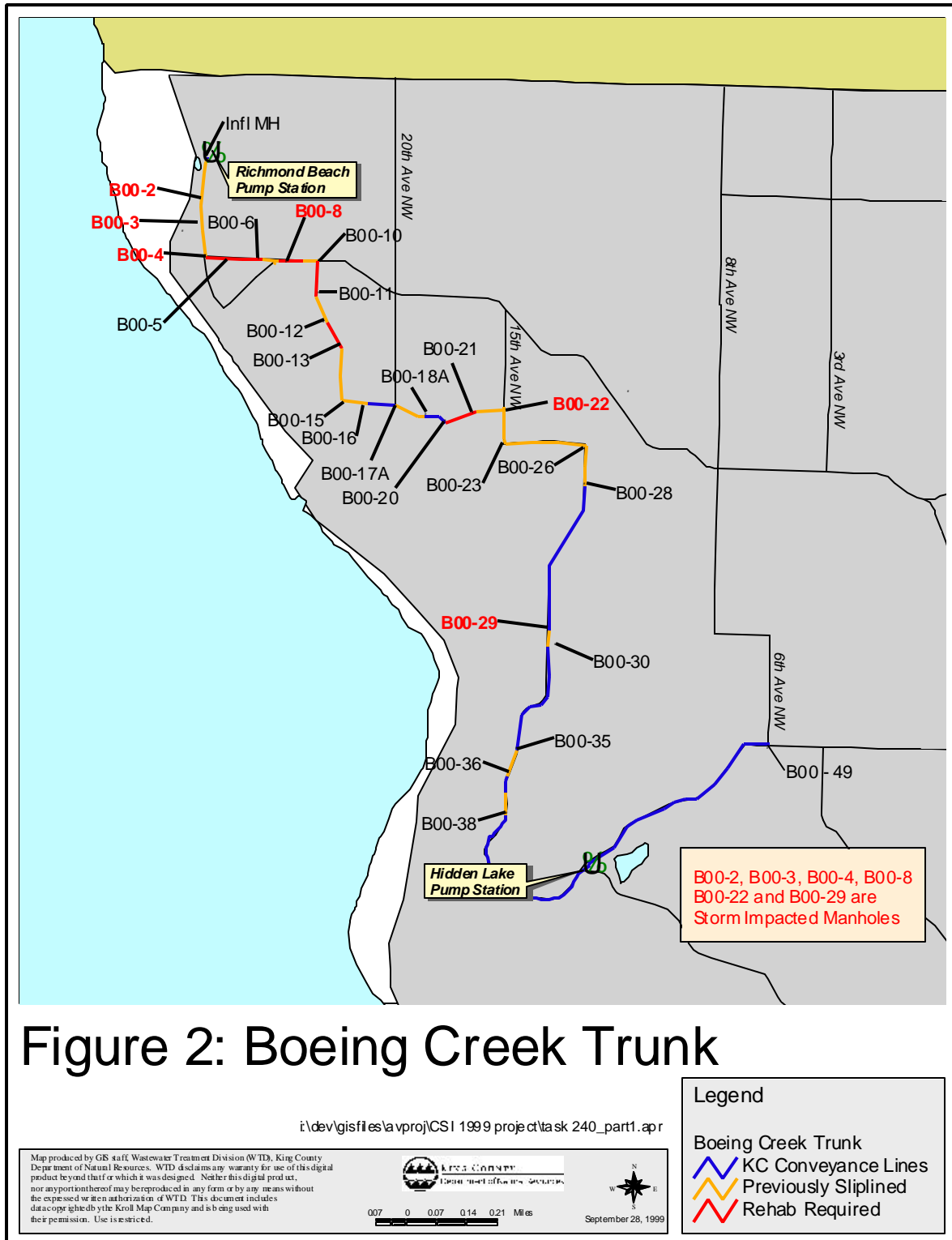
## CONVEYANCE SYSTEM AND HYDRAULIC CAPACITY OVERVIEW

The Hidden Lake Service Area comprises sewer basins that are tributary to the Hidden Lake Pump Station and sewer basins that discharge to King County facilities downstream of the Hidden Lake Pump Station, such as the Boeing Creek Trunk and Richmond Beach Pump Station (Figure 1). This includes approximately 2,495 acres of the Shoreline Wastewater Management District's (WMD) collection system, and the entire Highlands Sewer District (380 acres). The local collection system sewers discharge to the KC WTD conveyance system at the Hidden Lake Pump Station and numerous locations along the Boeing Creek Trunk.

A number of current conveyance capacity, odor control and pipe corrosion problems have been identified at King County facilities in the Service Area. These issues were described in detail in the Task 210 report, and are briefly summarized here.

1. The capacity of the Hidden Lake Pump Station is insufficient to pass wet weather flows. Currently the wet well overflows approximately twice per year during storm events. The stated firm pumping capacity is 4.2 MGD, but the actual capacity is probably closer to 3.8 MGD (Ed Cox, personal communication). This is significantly less than the estimated 20-year peak hour, tributary infiltration and inflow (I/I).
2. The capacity of the Boeing Creek Trunk downstream of the Hidden Lake Pump Station is more limited than the pump station, as evidenced by the higher occurrence of storm impacts. The most frequently affected manholes are B00-29, B00-22, B00-8, B00-4, B00-3 and B00-2, where surcharging and/or overflows have occurred. There has also been extensive sulfide-related corrosion along the pipeline. Previous sliplining work done in response to corrosion has further reduced hydraulic capacity along the Boeing Creek Trunk, increasing the frequency of storm impacts. Figure 2 shows locations of existing sliplined pipe and storm impacted manholes.





- Sulfide-related odor has been an on-going problem at the Hidden Lake Pump Station and Boeing Creek Trunk. Odor control equipment was temporarily installed at the wet well and a “no pu” device has been installed at the siphon forebay at manhole B00-29.

## HIDDEN LAKE SERVICE AREA POPULATION PROJECTIONS

To assess the future wastewater conveyance needs within the Service Area, population projections have been obtained from the 1997 City of Shoreline Comprehensive Plan, and the KC WTD. Future population growth within the Service Area will be concentrated in the Shoreline WMD. The Highlands SD serves a private community of approximately 100 homes. The Highlands has a covenant which maintains restrictive zoning rules that make new development unlikely.

### Shoreline WMD Population Projections

The City of Shoreline and KC WTD provided the current and future population data used in this study. However, in each case the population forecasts were not reported specifically for the Hidden Lake Service Area, but for larger areas of which the Service Area makes up a portion. For example, KC WTD reported a year 2000<sup>1</sup> population of 26,503 for the 3,988 acre Richmond Beach Basin, of which the Hidden Lake Service Area makes up approximately 2,875 acres<sup>2</sup>. Assuming the Richmond Beach Basin population density is similar both inside and outside the Service Area, a current population of 19,106 is estimated. This is somewhat larger than the 15,000 person estimate given by Shoreline WMD staff (see Task 210 report). This difference will have little impact on conveyance system capacity improvement requirements, since the wastewater base flows are only a small portion (~13% of 20-year peak flow, see Flow Projections below) of the total flow during peak storm events.

Both the KC WTD and City of Shoreline predict slow growth in the Service Area in the coming decades. According to KC WTD estimates, the residential population is expected to increase by 4.9% over the next 30 years (Table 1). The 1997 Shoreline Comprehensive Plan calls for an additional 1,600 to 2,400 residential units<sup>3</sup> (housing for approximately 4,600 people) to be constructed within the city during the 20 year planning window beginning in 1996. This level of anticipated growth is based on an agreement between the City of Shoreline and King County on how to allocate the population growth forecasted by the State Office of Financial Management (OFM) among urbanized communities in King County, in accordance with the Growth Management Act. Shoreline's future land use map shows zoning changes that encourage increased residential and commercial density at the following locations in the Service Area (see Task 230 report):

- Aurora Avenue in Shoreline WMD Basin 14, which is tributary to the Hidden Lake Pump Station.

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<sup>1</sup> These data reflect the June 1999 updates.

<sup>2</sup> The Richmond Beach Basin in the KC GIS *Service Basin* coverage includes some areas that drain to the Lake Ballinger Pump Station and the Olympic View Sewer District. These areas are not part of the Hidden Lake Service Area. The Service Area acreage was provided by KC WTD.

<sup>3</sup> For wastewater generation purposes, a residential unit is defined by King County as 2.4 people in 1996 and 2.2 people in 2010.

- Richmond Beach Road, which has connections to the gravity section of the Boeing Creek Trunk upstream of the Richmond Beach Pump Station.
- Point Wells, which is a potential annexation and development site north of the Richmond Beach Pump Station. Point Wells is served by Shoreline WMD Pump Station 13, which pumps wastewater along Richmond Beach Drive to KC manhole B00-04.

The Service Area covers 45% of the area of Shoreline and includes one third of the population. Based on this information and the zoning changes contained in the Shoreline Comprehensive Plan land use maps, 2,300 people (50% of city-wide growth) is a reasonable estimate of Shoreline's projected growth for the Service Area.

Of the population data examined here, the KC WTD population estimates are higher and therefore provide a more conservative basis for calculating wastewater generation rates. The differences in projected population between the two methods used result in a 0.3 MGD difference in base flow. In determining the required conveyance capacity for KC facilities, however, the differences between the two sets of population estimates are inconsequential, because the majority of peak storm flows are attributable to I/I.

**Table 1. Population projections for the Hidden Lake Service Area<sup>a</sup>**

**King County Wastewater Treatment Division Projections**

<b>Year</b>	<b>Residential</b>	<b>Commercial</b>	<b>Industrial</b>
2000	19,106	6,601	89
2010	19,556	6,834	105
2020	19,691	7,335	130
2030	20,036	7,656	149
2040	20,330	8,024	170
2050	20,622	8,391	190

**City of Shoreline Projections**

<b>Year</b>	<b>Residential</b>	<b>Commercial</b>	<b>Industrial</b>
2000	15,000	N/A	N/A
2020	17,300	N/A	N/A

a. The methods used to determine population are described above.

## **HIDDEN LAKE SERVICE AREA FLOW PROJECTIONS**

KC WTD provided estimates of base flow and I/I flow at the Hidden Lake Pump Station (Table 2). Their projections simulate the effect of conveyance system aging by increasing I/I by seven percent per decade until 2030, the standard used in the Regional Wastewater Services Plan (RWSP).

**Table 2. Projected peak flows at the Hidden Lake Pump Station**

Year	Base Flow (mgd)	5-year Peak I/I (gpad)	5-year Peak Flow (mgd)	20-year Peak I/I (gpad)	20-year Peak Flow (mgd)
1990	1.23	3,510	7.7	4,400	9.3
2000	1.22	3,770	8.2	4,710	9.9
2010	1.26	4,020	8.7	5,030	10.5
2020	1.28	4,270	9.2	5,350	11.2
2030	1.30	4,530	9.7	5,670	11.8
2050	1.34	4,530	9.7	5,670	11.8

Flow projections were computed along various reaches of the Boeing Creek Trunk by estimating the tributary area to each reach and assuming that both base flow and I/I generation are evenly distributed throughout the Service Area (Table 3). This method had previously been used by KC WTD to estimate flows at specific points in the Service Area. The Hidden Lake Pump Station has a tributary area of 1,831 acres. The tributary area of each reach was estimated from a detailed Shoreline WMD map showing sewer sub-basins. The reaches shown in Table 3 were chosen based on the location of major connections with Shoreline WMD local sewers.

**Table 3. Flow projections along the Boeing Creek Trunk for 2050**

Reach	Accumulated Tributary Area (ac)	5-Year Peak Flow (mgd)	20-Year Peak Flow (mgd)
B00-49 to HLPS <sup>a</sup>	1,300	6.9	8.4
HLPS to B00-38	1,831	9.7	11.8
B00-38 to B00-29	2,000	10.6	12.9
B00-29 to B00-23	2,100	11.1	13.5
B00-23 to B00-17	2,600	13.8	16.8
B00-17 to B00-04	2,750	14.6	17.7
B00-04 to RBPS <sup>b</sup>	2,875	15.2	18.5

a. Hidden Lake Pump Station

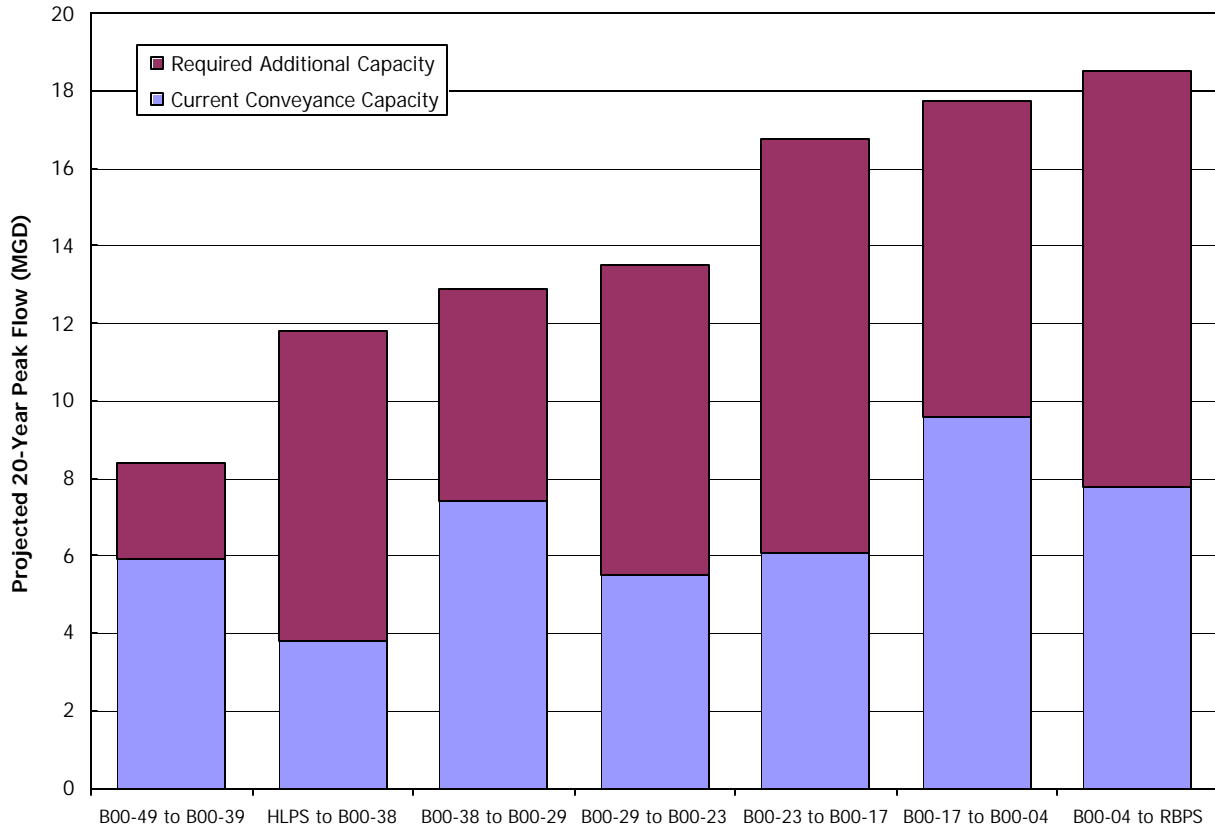
b. Richmond Beach Pump Station

A planning level estimate of the Boeing Creek Trunk conveyance capacity was computed along the reaches given in Table 3 using the Manning's equation for full pipe flow (Manning's friction factor,  $n=0.013$ ), with pipe lengths and average reach slopes provided by the KC GIS group. Estimates of conveyance system capacity, along with 20-year peak flows for each reach are shown in Table 4 and Figure 3.

**Table 4. Boeing Creek Trunk estimated existing conveyance capacities.**

Reach	Reach Length (ft)	Average Diameter (in)	Average Slope (%)	Capacity (mgd)	20-Year Peak Flow (mgd)
B00-49 to HLPS	2,803	15.0	2.0	5.9	8.4
HLPS to B00-38	2,375	14.0	FM	3.8 <sup>a</sup>	11.8
B00-38 to B00-29	2,476	16.8	1.7	7.4	12.9
B00-29 to B00-23	3,316	15.6	1.4	5.5	13.5
B00-23 to B00-17	2,260	18.0	0.8	6.1	16.8
B00-17 to B00-04	3,718	15.5	4.4	9.6	17.7
B00-04 to RBPS	872	21.3	0.5	7.8	18.5

a. Pump station capacity.



**Figure 3. Current and additional required capacity to convey 20-year peak storm along Boeing Creek Trunk.**

Figure 3 shows the current conveyance capacity is insufficient to pass the 20-year peak storm. The conveyance system alternatives developed in the next section must provide a method for either increasing the capacity of these facilities or reducing the flows through these facilities to the capacities given in Table 4.

## DEVELOPMENT OF CONVEYANCE SYSTEM IMPROVEMENT ALTERNATIVES

This section provides an overview of various approaches to reducing the frequency of conveyance system overflows to once per 20 years<sup>4</sup>. These approaches are organized into three general categories of alternatives:

- A. Upgrading the Capacity of Conveyance Facilities and Maintaining Current Wastewater Routing
- B. Using Storage to Control Conveyance System Overflows
- C. Diverting Peak Wet Weather Flows Away from the Boeing Creek Trunk

<sup>4</sup> King County RWSP standard for separated sewer areas.

Each alternative addresses the replacement, upgrading and/or construction of new KC facilities, construction factors (Appendix A), planning and permitting issues<sup>5</sup>, planning level costs and impacts on other KC WTD facilities. We have used 2050 flow projections in designing these alternatives. The Service Area is fully developed and using a 2010 planning horizon would reduce the size of required facilities but would not eliminate the need for additional facilities. The relative costs of the three alternatives would not be significantly affected by shortening the planning horizon.

#### Impacts of Alternatives on Edmonds Wastewater Treatment Plant

We have met with Edmonds Wastewater Treatment Plant (WWTP) staff to determine whether the plant can accept the additional flows that would result from reducing the frequency of sanitary sewer overflows (SSO) in the Service Area. The Edmonds WWTP has a permitted capacity of 11.8 MGD average monthly flow. The permitted capacity was exceeded in February 1999, when flows averaged 12.4 MGD. During this period, the Edmonds WWTP produced acceptable effluent suspended solids and BOD levels. Plant staff believe the Edmonds WWTP can handle additional flows and are interested in having the WWTP rerated to create a capacity buffer. With a higher rated capacity, the Edmonds WWTP would welcome additional flows from the King County conveyance system.

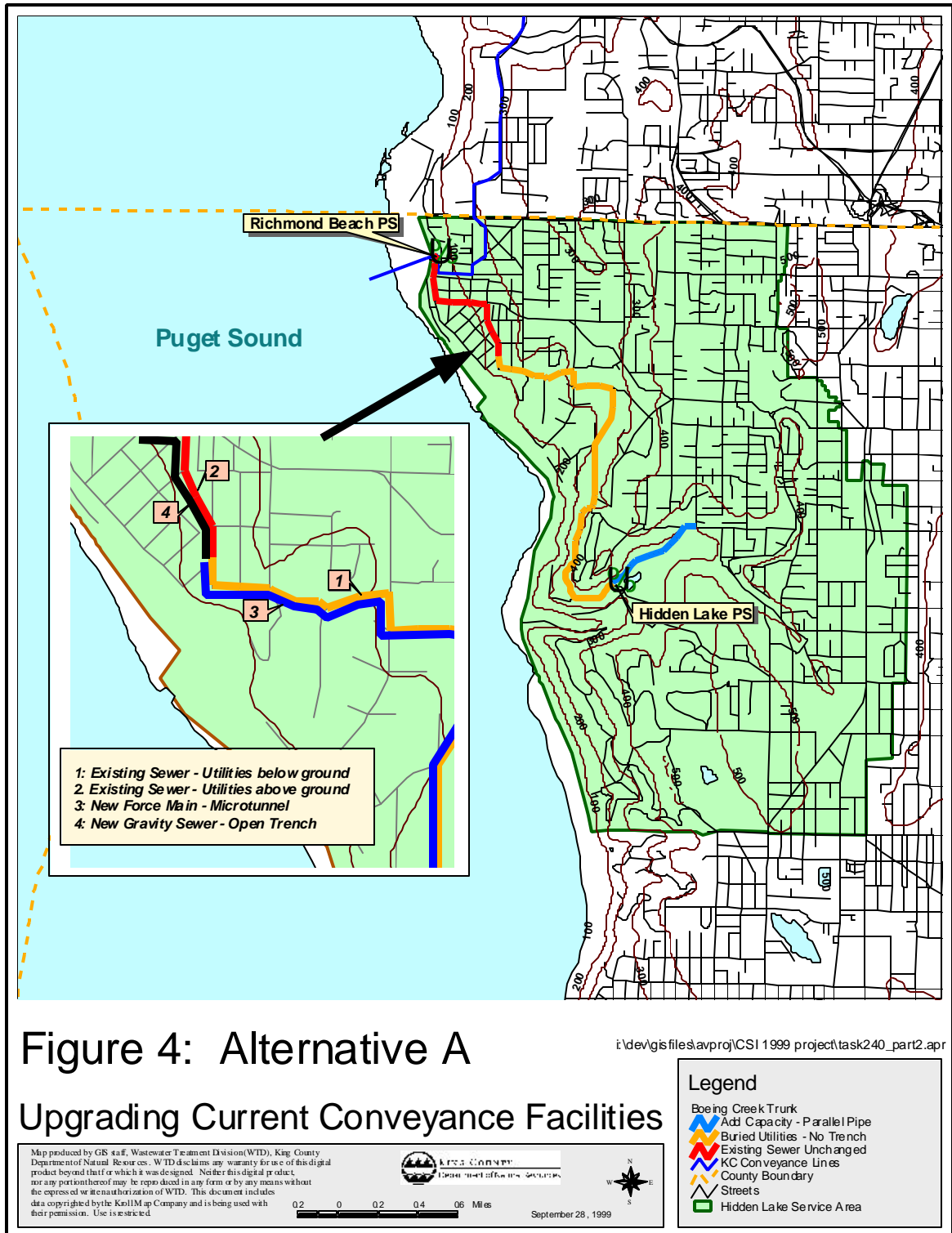
Alternative A and some sub-alternatives of Alternative C would increase the peak flows at the Edmonds WWTP. The pumping capacity of the plant is 40 MGD and the secondary treatment capacity is approximately 22 MGD. The maximum observed flow at the plant was 28 MGD (for one hour). During the December 1996/January 1997 storm, the plant received a steady influent of 22 MGD for more than 24 hours and still produced 10/10 effluent. Plant staff feel the WWTP can handle the higher peak flows that would result from increasing the hydraulic capacity of the KC system in the Service Area.

#### **Alternative A: Upgrading the Capacity of Conveyance Facilities and Maintaining Current Wastewater Routing**

The capacity of the conveyance system would be increased by replacing the Hidden Lake Pump Station with a larger pump station, adding capacity to the Boeing Creek Trunk with a new force main and parallel gravity sewer, and retrofitting/upsizing the Richmond Beach Pump Station (Figure 4). To reduce the potential for sulfide-related odors and corrosion, odor control equipment would be installed at the new Hidden Lake Pump Station and chemical dosing would be provided at the pump station discharge.

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<sup>5</sup> Planning and permitting issues, as well as environmental considerations are examined in the Task 250 report.



### Pump Station Upgrades

The Hidden Lake Pump Station has been in use since 1963 and would require a tripling of capacity to meet the 20-year peak flow (Table 5). This alternative would replace the existing pump station with a new, larger station, rather than retrofitting the existing station. We have identified a couple of potential sites for the new pump station.

1. The current property could adequately fit a new pump station, if undeveloped land is used. The property has two distinct sections: a relatively flat area that houses the existing pump station and an undeveloped, wooded ravine on the northeast side of the lot. If trees are cleared from the ravine and construction occurs on the slope, there is sufficient room to build an 11.8 MGD pump station.
2. There is a vacant lot at the northwest corner of NW 175<sup>th</sup> Street and 6<sup>th</sup> Avenue NW that is large enough for the new pump station. The property is owned by the City of Shoreline. Utilizing this property would require some modifications to the conveyance system. The Shoreline WMD Pump Stations No. 4 and No. 5 force mains discharge near the existing Hidden Lake Pump Station, which is one half mile away and is 70 feet lower than this proposed site for a new Hidden Lake Pump Station. Additional pumps could be used to lift flow to the new pump station, or the Shoreline WMD force mains could intersect the new Hidden Lake Pump Station force main.

The Richmond Beach Pump Station is less than 10 years old, and in good condition according to KC WTD staff. The existing pump station would be retrofitted or expanded to handle an additional 8.1 MGD peak flow. Finding room for expansion should not pose a problem. The Richmond Beach Pump Station sits on a large property with ample space for on-site expansion.

**Table 5. Upgraded pump station capacities**

	<b>Current Capacity (mgd)</b>	<b>Upgraded Capacity (mgd)</b>
Hidden Lake Pump Station	3.8	11.8
Richmond Beach Pump Station	10.4	18.5

### Adding Capacity to the Boeing Creek Trunk

The capacity of the Boeing Creek Trunk would be upgraded to meet flow projections (see Table 4) by constructing a new force main and parallel gravity sewer along the same route as the current trunk. We have examined the available utility maps and discussed previous construction work with KC WTD staff to determine if the existing underground utilities would affect sewer construction along the current route. The Innis Arden neighborhood is an area of concern. A number of buried utilities (storm sewer, water, cable, telephone, electricity, gas) could interfere with trench digging and sewer placement, according to KC WTD staff. For example, KC WTD has had difficulty installing air jumpers along the

double-barreled siphon between manholes B00-29 and B00-28. Interference from existing utilities could be avoided by tunneling a force main below existing utility lines.

The force main would extend from the Hidden Lake Pump Station to manhole B00-14. Downstream of B00-14, a gravity sewer could be constructed using conventional techniques, because fewer utilities are located below ground. The new force main/gravity sewer would have an 11.8 MGD capacity and no connections to local agency sewers. The current 3.8 MGD force main (Hidden Lake Pump Station to B00-38) would be abandoned, but the existing downstream gravity section of the Boeing Creek Trunk would remain active and would be used to collect wastewater from Shoreline WMD connections. The initial reaches of the Boeing Creek Trunk (B00-49 to B00-39) would require some modification. If the new pump station is located on the current property, additional capacity will be required upstream of the pump station. If the new pump station is located at NW 175<sup>th</sup> Street and 6<sup>th</sup> Avenue NW, flows would be rerouted to the new station. Table 6 shows the proposed configuration of the Boeing Creek Trunk assuming the new pump station is built on the same property as the current station.

**Table 6. Boeing Creek Parallel Trunk required pipe diameters**

Reach	20-year Peak Flow (mgd) <sup>a</sup>	Conveyance Capacity (mgd)	Length (ft)	Average Slope (%)	Pipe Diameter (in)
<i>Alternative A Proposed Force Main and Gravity Sewer:</i>					
HLPS to B00-14	11.8	11.8	11,343	FM	21 <sup>b</sup>
B00-14 to RBPS	11.8	11.8	3,455	4.4	18
<i>Existing Gravity Sewer:</i>					
B00-49 to HLPS <sup>c</sup>	8.4	5.9	2,803	2.0	15
B00-38 to B00-29	1.1	7.4	2,476	1.7	18
B00-29 to B00-23	1.7	5.5	3,316	1.4	18
B00-23 to B00-17	5.0	6.1	2,260	0.8	24
B00-17 to B00-04	5.9	9.6	3,718	4.4	24
B00-04 to RBPS	6.7	7.8	872	0.5	30

a. Downstream of the Hidden Lake Pump Station, peak flows are split between the new and existing sewers. Example: the total flow between B00-29 and B00-23 is 11.8 + 1.7 MGD = 13.5 MGD as reported in Table 4.

b. The force main has been sized to maintain a liquid velocity less than 8 ft/s.

c. Additional hydraulic capacity would be required along the reach.

Tunneling along the current Boeing Creek Trunk route from the Hidden Lake Pump Station to the Richmond Beach Pump Station is a feasible alternative, but there are several undesirable factors that should be considered and mitigated. The new force main will have a net elevation drop of 116 feet. A flow control/energy dissipation device(s) would be required to avoid siphoning at the intermediate high point in the force main, near manhole B00-38.

The turbulent discharge at the end of a long force main would release hydrogen sulfide gas. Odor control equipment would be installed to control off-gassing.

The pump station and trunk expansions discussed in Alternative A would impact the 15,000 foot King County owned Richmond Beach – Edmonds Interceptor and Force Main. While not explicitly considered part of the Hidden Lake Service Area in Tasks 210, Task 220 and Task 230, the Richmond Beach – Edmonds Interceptor and Force Main is included in the development of alternatives. We have estimated the conveyance capacity of this interceptor using Manning’s equation for full pipe flow. The 20-year peak flow of 18.5 MGD could be conveyed along several sections of the existing interceptor, while other sections would require additional capacity either through pipe upsizing or parallel piping. Table 7 shows the conveyance capacity of the Richmond Beach – Edmonds Interceptor and Force Main and the size of the parallel pipe that would provide enough capacity to meet the 20-year peak flow. The current force main would need to be upsized or paralleled, and approximately 3,100 feet of gravity sewer would require additional capacity.

**Table 7. Flow projections and hydraulic capacity of the Richmond Beach – Edmonds Force Main and Interceptor**

Reach	20-year Peak Flow (mgd)	Current Conveyance Capacity (mgd)	Length (ft)	Average Slope (%)	Avg. Pipe Diameter (in)	Required Parallel Pipe Diameter (in)
RBPS to MH 32A	18.5	11.3	5,551	FM	20.0	16 <sup>a</sup>
MH 32A to MH 29	18.5	11.1	1,430	0.6	24.0	18
MH 29 to MH 23	18.5	19.1	1,826	2.0	24.7	N/A
MH 23 to MH 19	18.5	11.9	1,709	0.2	30.0	21
MH 19 to MH 1	18.5	29.2	4,835	3.9	25.1	N/A

a. The force main has been sized to maintain a liquid velocity less than 8 ft/s.

Upgrading the conveyance system will increase the peak and volumetric flows arriving at the Edmonds WWTP. Early discussions with treatment plant staff suggest that rerating the plant capacity would be required to accept additional flows. Minimal, if any, hydraulic modifications would be required at the treatment plant.

## **Alternative B: Using Storage to Control Conveyance System Overflows**

Alternative B examines storing peak storm flows as a method of controlling system overflows while limiting the need for upgrading King County facilities. A Storage tank would be associated with either the Hidden Lake Pump Station or the Richmond Beach Pump Station (Figure 5). In performing this analysis, we assume that storage sites are available in the vicinity of the pump station and that all storage will be offline.

The availability of space for siting a storage tank is subject to further study, but our preliminary field visits suggest siting a tank at the Richmond Beach Pump Station would be possible. There is less room for a storage tank at the Hidden Lake Pump Station. Its proximity to a ravine and the level of development in the surrounding residential neighborhood dictate that the storage tank would be located off-site, and would require additional conveyance facilities. The nearest feasible locations are Shoreview Park and Shoreline Community College.

#### Storage Tank Near the Hidden Lake Pump Station

KC WTD provided estimates of the storage volume necessary to control a 20 year storm for pumping rates of 4, 6 and 8 MGD at the Hidden Lake Pump Station. Using the data provided by KC WTD, Brown and Caldwell computed the required storage volume for a pumping rate of 3.8 MGD, which corresponds to the maximum pumping rate estimate given by Ed Cox of KC WTD.

**Table 8. Storage tank volume at Hidden Lake Pump Station for a 20-Year storm**

<b>Pumping Rate (mgd)</b>	<b>Storage Volume (MG)</b>
3.8	2.4
4.0	2.2
6.0	1.0
8.0	0.54

Associating a 2.4 MG storage tank with the Hidden Lake Pump Station would allow the maximum pumping rate to remain at 3.8 MGD, and effectively reduce the projected 20-year peak flow downstream of the pump station by 8 MGD. This would have the following impacts on KC facilities in the Service Area:

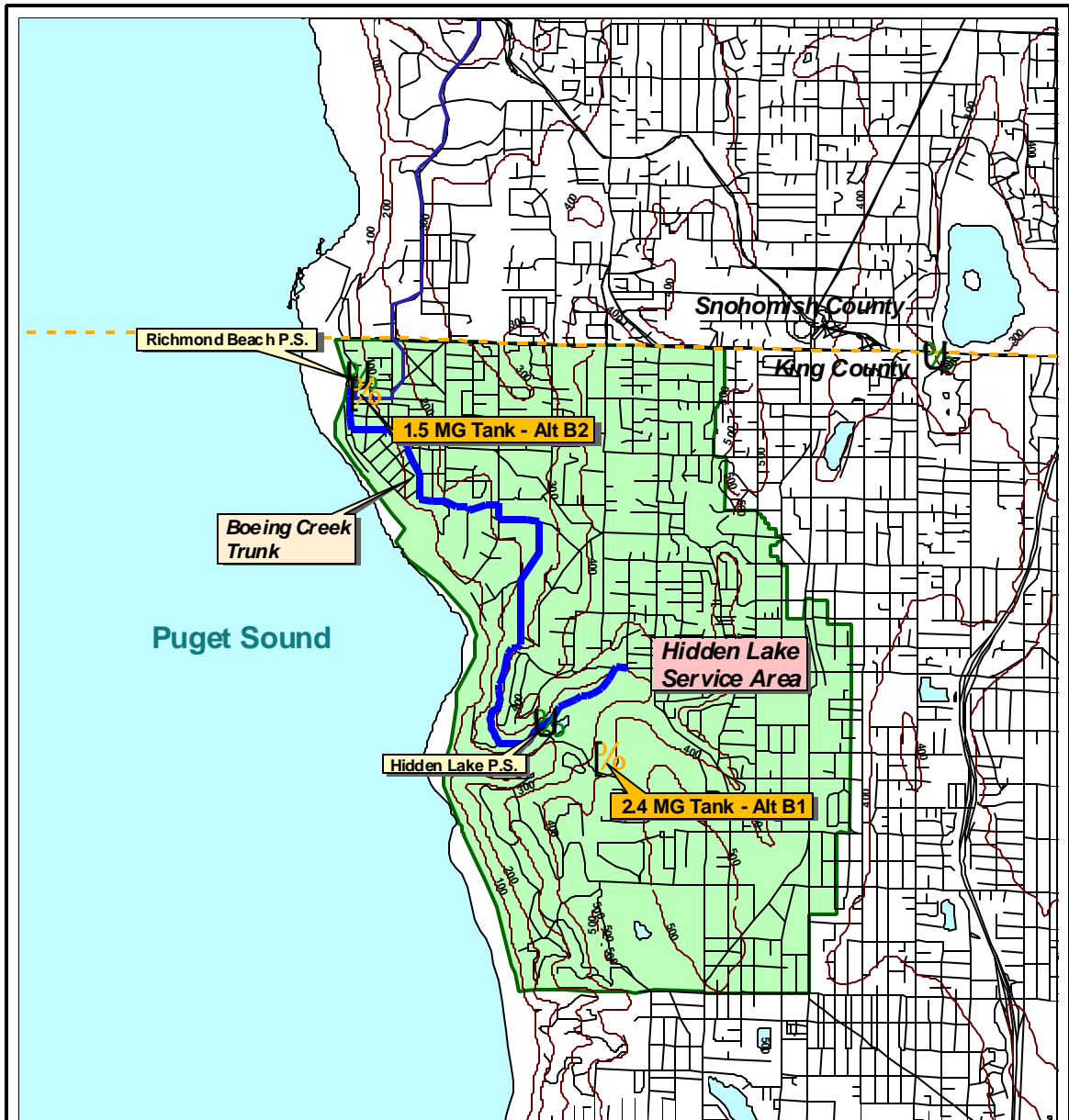
1. The Hidden Lake Pump Station would not require additional capacity, but odor control equipment would still be required.
2. The Boeing Creek Trunk would still require additional capacity upstream of the Hidden Lake Pump Station and downstream of manhole B00-29.
3. The Richmond Beach Pump Station has a capacity of 10.4 MGD (all pumps) and would probably not require expansion or retrofitting.
4. The Richmond Beach – Edmonds Interceptor and Force Main has a capacity similar to the Richmond Beach Pump Station and would probably not require any additional capacity.

The storm impacts that currently occur downstream of manhole B00-29 are evidence that additional capacity is necessary at the current maximum pumping rate. Table 9 shows the 20-year peak flows along the Boeing Creek Trunk, assuming an offline 2.4 MG storage tank is associated with the Hidden Lake Pump Station. For reaches downstream of the pump station, the flow values are 8 MGD less than the peak flow values reported in Table 4. However, downstream of manhole B00-29, the current trunk capacity is insufficient and either a parallel trunk or a larger, replacement trunk would be required. Approximately 13,000 feet of the Boeing Creek Trunk would require a parallel or replacement pipe. Buried utilities would complicate construction, as described in Alternative A.

**Table 9. Boeing Creek capacity with 2.4 MG storage at Hidden Lake Pump Station**

Reach	20-year Peak Flow (mgd)	Current Capacity (mgd)	Parallel Trunk Capacity (mgd)	Length (ft)	Average Slope (%)	Pipe Diameter (in)
B00-49 to HLPS	8.5	5.9	2.6	2,803	2.0	15
HLPS to B00-38	3.8	3.8	0.0	2,375	FM	N/A
B00-38 to B00-29	4.9	7.4	0.0	2,476	N/A	N/A
B00-29 to B00-23 <sup>a</sup>	5.53	5.48	0.05	3,316	1.4	12
B00-23 to B00-17	8.8	6.1	2.7	2,260	0.8	15
B00-17 to B00-04	9.7	9.6	0.2	3,718	4.4	15
B00-04 to RBPS	10.5	7.8	2.8	872	0.5	15

a. 20-year peak flow and current capacity values are similar. However, there are reported storm impacts along this reach.



**Figure 5: Alternative B**  
Storing Peak Wet Weather Flows

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0.2 0 0.2 0.4 0.6 Miles

September 28, 1999

### Storage Tank at the Richmond Beach Pump Station

KC WTD prepared an estimate of the required storage volume at the Richmond Beach Pump Station to control the 20 year design storm, assuming the upstream conveyance facilities are capable of delivering all flows within the Service Area to the Richmond Beach Pump Station.

**Table 10. Storage tank volume at Richmond Beach Pump Station for a 20-Year storm**

Pumping Rate (mgd)	Storage Volume (MG)
10.0	1.5

Even though the peak flow at the Richmond Beach Pump Station is substantially higher than at Hidden Lake Pump Station (see Table 3), the estimate of required storage volume at the Richmond Beach Pump Station is lower than at Hidden Lake. This is because a smaller fraction of the design storm hydrograph used to derive these storage volume estimates surpasses the capacity of the Richmond Beach Pump Station than the Hidden Lake Pump Station. Constructing a 1.5 MG storage tank at the Richmond Beach Pump Station would impact the following KC facilities:

1. The Hidden Lake Pump Station would need to be replaced with a larger station, as described in Alternative A.
2. The Boeing Creek Trunk would require a new 11.8 MGD force main and gravity sewer and either flow rerouting or additional capacity between manholes B00-49 and B00-39. See Alternative A for details.
3. The Richmond Beach Pump Station would not require upgrades or retrofits.
4. The Richmond Beach – Edmonds Interceptor and Force Main would not require additional capacity.

The storage tank would be placed under the pump station driveway. During the construction of the Richmond Beach Treatment Plant in the early 1960s, KC WTD staff encountered deep soils under much of the property. The deep soils make it very likely that support piling will be required for any storage tank built on the property. This could potentially increase the cost of storage at Richmond Beach (see Cost Estimates).

### **Alternative C: Diverting Peak Wet Weather Flows Away from the Boeing Creek Trunk**

This alternative would avoid upgrading some existing facilities by routing peak storm flows away from the Hidden Lake Pump Station and Boeing Creek Trunk. The collection point for the conveyance bypass line would be located at the upstream end of the Boeing Creek Trunk (MH B00-49). Manhole B00-49 isolates Shoreline WMD Basin 14, which is the largest

Shoreline WMD sewer basin at 1,300 acres, and has an estimated 20-year peak flow of 8.4 MGD.

A pump station would be constructed on the vacant lot at the corner of NW 175<sup>th</sup> Street and 6<sup>th</sup> Avenue NW. This property is currently owned by the City of Shoreline and has an assessed value of approximately \$500,000. There are two options for sizing the pump station, 8.4 MGD or 11.8 MGD. An 8.4 MGD pump station could intercept the 20 year peak flow at manhole B00-49. In this case, the Hidden Lake Pump Station could remain at its current size, but downstream reaches of the Boeing Creek Trunk would require additional capacity. In order to maintain the current capacity of the Boeing Creek Trunk, an 11.8 MGD pump station would be constructed on the site, and the Hidden Lake Pump Station effluent would be redirected towards the new pump station. The current Hidden Lake Pump Station force main could be abandoned, similar to Alternative A.

A 2 to 2.5 mile long force main would be constructed along a ridge top, roughly parallel to 8<sup>th</sup> Avenue NW, that would convey wastewater over the county line into the town of Woodway (Figure 6). The force main would discharge into a one mile long, gravity sewer that would follow the local topography, sloping downward to the west, and connecting to the Richmond Beach – Edmonds Force Main and Interceptor in the vicinity of manhole 32A<sup>6</sup>, near 114<sup>th</sup> Avenue W Park Road and 238<sup>th</sup> Street SW. Two sections of the Richmond Beach – Edmonds Interceptor, totaling 3,100 feet in length, would be paralleled to increase capacity (similar to Alternative A, see Table 7). A King County constructed and owned sewer is probably the only option for connecting the new force main to the Richmond Beach – Edmonds Interceptor, because the Draft Edmonds Comprehensive Plan indicates the local sewers do not have enough additional capacity.

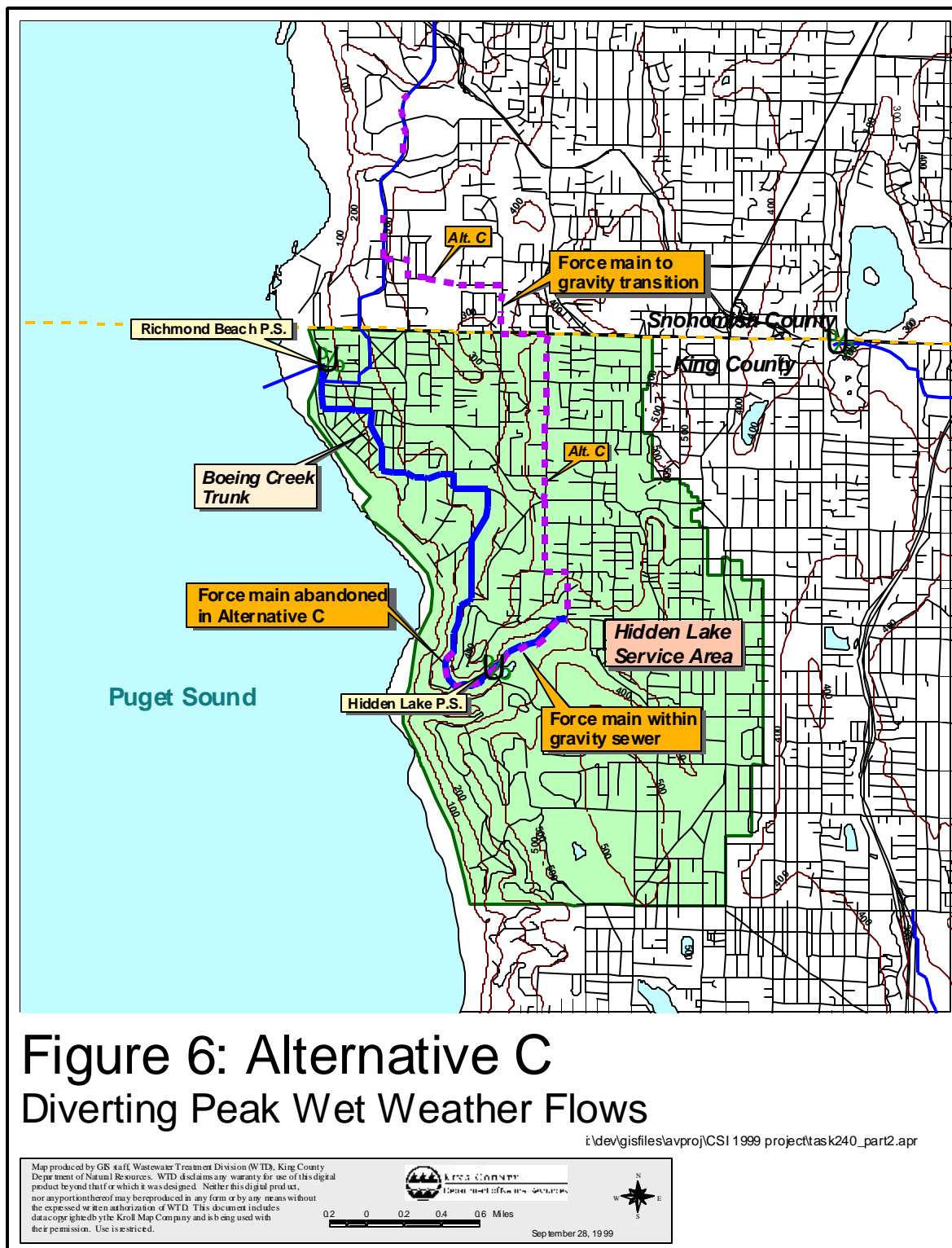
**Table 11. Alternative C facility sizing**

	<b>Pumping Rate (mgd)</b>	<b>Force Main Diameter<sup>a</sup> (in)</b>	<b>Force Main Length (ft)</b>	<b>Gravity Sewer Diameter<sup>b</sup> (in)</b>	<b>Gravity Sewer Length (ft)</b>
Alternative C1	8.4	18	10,500	24	5,000
Alternative C2	11.8	21	10,500	27	5,000

Force main sized to keep maximum velocity below 8 ft/s.

Gravity sewer size based on Manning's full-pipe flow equation. The average slope is 0.5%

<sup>6</sup> Manhole 32A is the location of the transition from force main to gravity in the Richmond Beach – Edmonds Force Main and Interceptor.



This alternative is similar to Alternative A with the following differences:

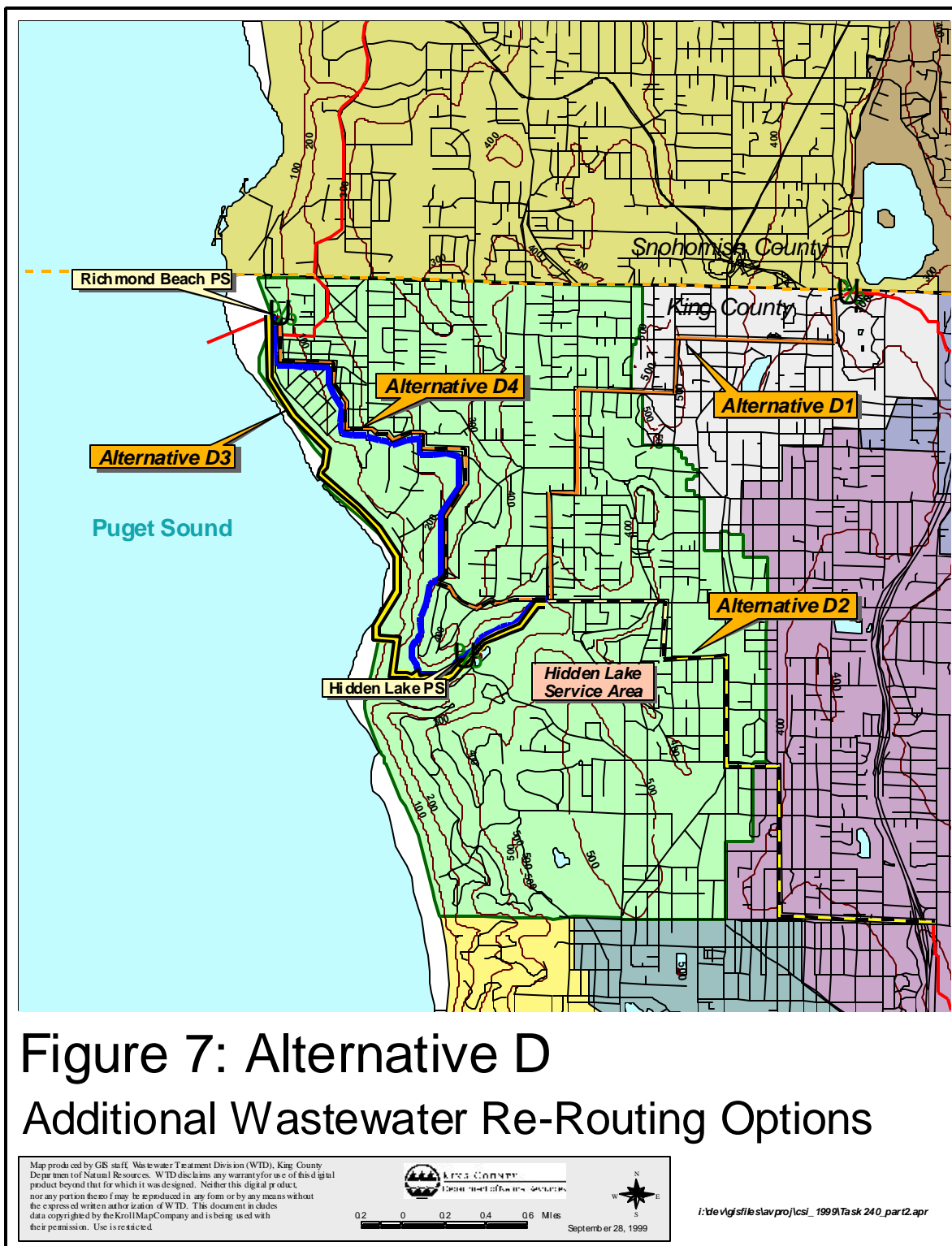
- Advantage: One pump station would be constructed/upsized instead of two.
- Advantage: Constructing a new sewer among existing underground utilities would be simpler with the Alternative C route, because there are fewer buried utilities than with the current Boeing Creek Trunk route.
- Disadvantage: Constructing a force main and gravity sewer along a new route would require a greater level of field reconnaissance and as yet unforeseen difficulties.

This option also provides flexibility for future changes to the KC WTD conveyance system in response to the siting of the North Treatment Plant. Wastewater could be directed by gravity from the force main discharge to the Edmonds WWTP, the Richmond Beach Pump Station, and potentially, the Lake Ballinger Pump Station.

### **Additional Alternatives**

The following alternatives were also considered. Initially, these appear less promising than Alternatives A – C, and are only described briefly here (Figure 5).

- Alt D1. Pump peak wet weather flows to the northwest to the Lake Ballinger Pump Station.
- Alt D2. Transfer flows to the Matthews Park Basin by pumping to the southwest, over the ridge near Aurora Avenue and towards the North Lake City Trunk.
- Alt D3. Route a new pressure sewer to either Shoreline Pump Station No. 4 or No. 5, continuing down the bluff, then turning northward adjacent the railroad tracks or along the beach to the Edmonds wastewater Treatment Plant.
- Alt D4. Tunnel a new pressure sewer under NW 175<sup>th</sup> Street to 15<sup>th</sup> Avenue NW where it would rejoin the Boeing Creek Trunk near manhole B00-33.



#### Alternative D1: Route Flows to the Lake Ballinger Pump Station

Wastewater could be routed into the McAleer and Lyon Basin by a new pump station and a three mile long, combination force main/gravity sewer. The new sewer would discharge to the Lake Ballinger Pump Station. After having its capacity increased, the Lake Ballinger Pump Station could pump the wastewater to either the Edmonds WWTP or the McAleer Trunk. The bi-directional pumping capability of the Lake Ballinger Pump Station would provide flexibility to deliver wet weather flows to a North Treatment Plant, once a site is determined. Despite these advantages, there are a couple of substantial drawbacks to this option:

- For conveyance to the Edmonds WWTP, pumping first to the Lake Ballinger Pump Station is an indirect route and requires two pump station, each with more than 150 feet of static lift.
- Pumping to the McAleer Trunk would add flow to the Kenmore Interceptor and downstream sections of the King County conveyance system that are already overloaded in wet weather conditions.

#### Alternative D2: Route Flows to the Matthews Park Basin

A three and a half mile long force main/gravity sewer could be routed to the southeast to the beginning of the North Lake City Trunk, at the City of Seattle boundary, and into the Matthews Beach Basin. This would help reduce the number of storm impacts in the Service Area and would add no additional flow to the Edmonds WWTP, but it would stress other parts of the King County conveyance system. The North Lake City Trunk would probably require additional capacity to accept the diverted flows. The North Lake City Trunk discharges to the Thornton Creek Interceptor and the Matthews Park Pump Station. The pump station is currently capacity limited.

#### Alternative D3: Route Flows Along Beach/Railroad Tracks

A new pressure sewer could be constructed to run towards Shoreline Pump Stations No. 4 and No. 5 and then down the bluff near Puget Sound. The pipeline could run northward to run either adjacent to railroad tracks or along the beach to the Edmonds WWTP. The wet weather flows could be conveyed to the Richmond Beach Pump Station entirely by gravity, avoiding most major upgrades to Hidden Lake Pump Station and Boeing Creek Trunk. Despite the potential capital, and operations and maintenance advantages, there are a number of structural and environmental concerns that make this alternative less attractive:

- KC WTD previously ran an overflow line down this bluff, but kept losing the pipe to land movements.
- The railroad tracks at the bottom of the bluff run so close to the hillside that pipe construction would have to occur on the west side of the tracks. The west side of the tracks borders a wetland with potential salmon habitat.

- There would be no appropriate way to flush accumulated solids from the flat part of the pipeline, running near the beach. It is very likely to produce odors on the beach during the summer.

#### Alternative D4: Route Flows Through a Deep Tunnel Along NW 175<sup>th</sup> Street

A pressure sewer could be tunneled underneath NW 175<sup>th</sup> Street from 6<sup>th</sup> Avenue NW to 15<sup>th</sup> Avenue NW, before meeting up with the Boeing Creek Trunk near manhole B00-33. This option has the advantage of being more direct than the current Boeing Creek Trunk route, and it would eliminate the need to upsize the Hidden Lake Pump Station. However, it does not help reduce flows along most of the Boeing Creek Trunk, and the tunnel would need to be continued to manhole B00-14 (see Alternative A). Additionally, NW 175<sup>th</sup> Street is a winding residential street, so the tunnel would have several turns. The maximum depth would be approximately 100 feet, requiring deep jacking/receiving pits.

### **Cost Estimates for Alternatives**

Preliminary cost estimates were prepared for the parallel trunk sewer and pump stations, based on cost curves and information gathered on the Service Area. Our assumptions include 5 percent for mobilization/demobilization, 30 percent for contingencies, 10 percent for legal fees, 20 percent for engineering management and 8.6 percent tax. Extra costs are noted individually for the specific alternatives below. A more detailed cost analysis will be developed as the alternatives are researched further.

#### Cost Estimates – Alternative A

Table 12 shows planning level project cost estimates for Alternative A.

**Table 12. Planning level cost estimates – Alternative A**

<b>Facility</b>	<b>Length or Capacity</b>	<b>Cost (million dollars)</b>
Hidden Lake Pump Station	11.8 mgd	5.2
Boeing Creek Trunk	17,800 ft	13.0
Richmond Beach Pump Station	8.1 mgd	6.3
Richmond Beach – Edmonds Force Main and Interceptor	8,700 ft	4.4
<b>Total Project Cost</b>		<b>28.9</b>

The Boeing Creek Trunk cost estimate takes into account material costs, excavation pits and tunneling, mobilization/demobilization, traffic control and surface restoration as required,

engineering management, tax and contingencies. The Hidden Lake Pump Station cost estimate includes capital costs, mobilization/demobilization, engineering management, tax, contingencies, odor control and chemical dosing equipment. The cost estimate for the Richmond Beach Pump Station expansion is based on the 1991 project cost for pump station construction (\$6.25 million). The expansion would increase the pump station capacity by 80 percent, so the original cost has been multiplied by 80 percent and a 4 percent annual inflation rate has been applied. The cost of the Richmond Beach – Edmonds Force Main and Interceptor includes material costs, excavation and trench support, mobilization/demobilization, traffic control and surface restoration, engineering management, tax and contingencies.

#### Cost Estimates – Alternative B1, Storage at the Hidden Lake Pump Station

Table 13 shows planning level cost estimates for a 2.4 MG, offline storage tank at the Hidden Lake Pump Station and associated conveyance facilities, installation of odor control and chemical dosing equipment at the Hidden Lake Pump Station, and a parallel trunk sewer. Locating a storage tank at Shoreview Park or the Shoreline Community College would require a regulator structure for diversion of flows upstream of the Hidden Lake Pump Station, conveyance to the storage tank, and a pump station and force main from the storage tank to the Boeing Creek Trunk.

**Table 13. Planning level cost estimates – storage at Hidden Lake Pump Station**

<b>Facility</b>	<b>Length or Capacity</b>	<b>Cost (million dollars)</b>
Hidden Lake Storage Tank	2.4 MG	13.2
Regulator and Connecting Pipeline to Storage Tank	2,500 ft	1.6
8 MGD Pump Station from Storage Tank	8 MGD	4.7
8 MGD Force Main	2,500 ft	2.1
Hidden Lake Odor Control and Chemical Dosing Equipment	N/A	0.5
Boeing Creek Trunk	13,000 ft	9.2
<b>Total Project Cost</b>		<b>31.3</b>

A \$5.5 per gallon project cost was assumed for the storage tank cost, based on estimating techniques used for the King County RWSP and Combined Sewer Overflow (CSO) projects. This cost assumes that a suitable location for the storage tank is available. The odor control and chemical dosing equipment costs are based on Brown and Caldwell previous experience. The Boeing Creek Trunk parallel line costs are calculated in the same manner as Alternative A.

Cost Estimates – Alternative B2, Storage at the Richmond Beach Pump Station

Table 14 shows planning level cost estimates for a 1.5 MG, offline storage tank (with piling) at the Richmond Beach Pump Station, replacing the existing Hidden Lake Pump Station and constructing a parallel Boeing Creek Trunk.

**Table 14. Planning level cost estimates – storage at Richmond Beach Pump Station**

Facility	Length or Capacity	Cost (million dollars)
Richmond Beach Storage Tank	1.5 MG	9.1
Hidden Lake Pump Station	11.8 mgd	5.2
Boeing Creek Trunk	17,800 ft	13.0
<b>Total Project Cost</b>		<b>27.3</b>

Cost Estimates – Alternative C1, Construction of 8.4 MGD Pump Station near B00-49

Table 15 shows estimated project costs for constructing a 8.4 MGD pump station on the vacant lot near manhole B00-49, acquisition of the property, upgrades to the Boeing Creek Trunk, construction of a new force main and gravity sewer connecting with the Richmond Beach - Edmonds Interceptor and some upgrades to the Interceptor upstream of the Edmonds WWTP.

**Table 15. Planning level cost estimates - diverting peak flows with an 8.4 MGD pump station**

Facility	Length or Capacity	Cost (million dollars)
Regulator and 8.4 MGD Pump Station	8.4 MGD	5.8
Property Acquisition	N/A	0.5
New 18-inch, 8.4 MGD Force Main	10,500 ft	5.9
New 24-inch, 8.4 MGD Gravity Sewer	5,000 ft	6.2
Upgrades to Boeing Creek Trunk	13,000 ft	9.2
Upgrades to Richmond Beach Int.	3,100 ft	1.6
<b>Total Project Cost</b>		<b>29.2</b>

Cost Estimates – Alternative C2, Construction of 11.8 MGD Pump Station near B00-49

Table 16 shows estimated project costs for constructing a 11.8 MGD pump station near manhole B00-49, rerouting Hidden Lake Pump Station effluent to the new pump station,

construction of a 11.8 MGD force main and gravity sewer to connect with the Richmond Beach - Edmonds Interceptor and Interceptor upgrades.

**Table 16. Planning level cost estimates - diverting peak flows with an 11.8 MGD pump station**

<b>Facility</b>	<b>Length or Capacity</b>	<b>Cost (million dollars)</b>
Regulator and 11.8 MGD Pump Station	8.4 MGD	6.4
Property Acquisition	N/A	0.5
Reroute HLPS Flow (3.4 MGD)	3.4 MGD	4.0
New 21-inch, 11.8 MGD Force Main	10,500 ft	6.3
New 27-inch, 11.8 MGD Gravity Sewer	5,000 ft	6.6
Upgrades to Richmond Beach Int.	3,100 ft	1.6
<b>Total Project Cost</b>		<b>25.4</b>

Table 17 compares the project costs for the three alternatives examined in Task 240. Alternative C has the lowest costs. These estimates should be considered highly preliminary; a more detailed examination of project costs will be included in Task 250 and Task 310.

**Table 17. Summary of project cost estimates for Alternatives A - C**

<b>Conveyance System Improvement Alternative</b>	<b>Cost (million dollars)</b>
Alternative A – Increase conveyance capacity	28.9
Alternative B1 – Offline storage at the Hidden Lake Pump Station	31.3
Alternative B2 – Offline storage at the Richmond Beach Pump Station	27.3
Alternative C1 – Diverting Peak Flows Away from Boeing Creek Trunk with 8.4 MGD Pump Station	29.2
Alternative C2 – Diverting Peak Flows Away from Boeing Creek Trunk with 11.8 MGD Pump Station	25.4

## **APPENDIX A**

### **Steep Slope and Erosion Hazard Area Permitting Considerations within the City of Shoreline**

Construction in steep slope (greater than 40 percent) or erosion hazard areas within the City of Shoreline is governed by Title 18 of the city's Zoning Code. The City of Shoreline (Shoreline) requires a sensitive area review for any alteration on a site that includes a sensitive area or is within an identified sensitive area buffer. As part of the sensitive area review, Shoreline will determine whether a sensitive area special study is required.

A sensitive area special study is a written report that identifies and characterizes all sensitive areas in the development area. It should include an assessment of the impacts of any site alteration, and propose adequate mitigation, maintenance, monitoring, or bonding requirements. In the event of steep slope and/or erosion hazard areas, the special study would likely include a geotechnical review and soils evaluation by a geologist or geotechnical engineer.

Per 18.24.310 of the Shoreline Zoning Code, utility corridors may be allowed on steep slopes if a special study shows that alteration will not subject the area to the risk of landslide or erosion.